Chiral Electro-Optic Metasurfaces

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In electro-optic (EO) materials, the optical properties change when the materials experience external static or low frequency electric field. When used in metasurfaces, such materials can be used to dynamically control light amplitude, phase, and polarisation. Lithium niobate (LN) is a widely used EO material and it is known for its fast switching speed (tens of GHz) and low power consumption [1]. Recently, it was proposed to use LN in metasurfaces with the aim of creating tunable metasurfaces [2]. To date, most woks focused on tuning amplitude and phase of the waves, and in this work we study possibilities of tunable polarisation control using metasurfaces containing LN.

In this work, we study a direct and an inverse anisotropic structure (sometimes referred to as 2D chiral structure) made of Z-cut LN on the silica substrate, see schematics in Figure below. We assumed that the properties of LN can be changed by applying an external electric field, and we studied the performance of polarisation control. In particular, we looked at the cross-polarisation conversion of linear incident polarisation as well as at tunable circular dichroism (CD) that can be achieved in these structures.

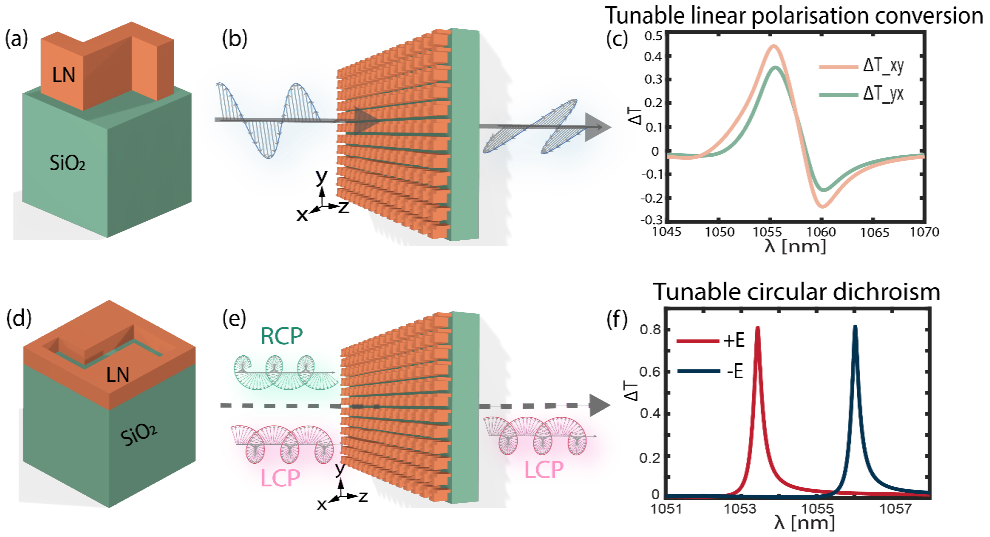

Figure1: Schematics of direct (a) and inverse (d) chiral structures. Conversion of linear polarization into orthogonal state (b) and circular dichroism (f). By applying an electric field to structures, we are able to substantially tune the cross-polarisation conversion of linearly polarised waves and also to tune the circular dichroism (f).

The designed chiral structures are able to convert vertical (Y) into horizontal (X) polarisation and vice versa. The transmission difference of linear polarisation induced by negative (-E) and positive (+E) control electric fields is around 0.5. The predicted efficiency in CD tuning is close to 0.8. Such structures are excellent candidates for creating tunable filters that control polarization of light.

[1] Benea-Chelmus, et al. Nature Communications 13.1 (2022): 1-9.

[2] Bar-David J, et al. Nano letters, 2017, 17(2): 1127-1131.